

Consolidation of Flight Food Provisioning for Human Space Flight

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The Space Food Systems Laboratory (SFSL) is a multipurpose laboratory responsible for the production of food and related hardware for NASA space flight, as well as the research and development of space foods and space food packaging. Located on site at Johnson Space Center (JSC), this facility supports the production and development of flight food, menus, packaging, and food-related hardware for all NASA programs, including the Space Transportation System (STS) Space Shuttle Program and the International Space Station (ISS). The facility also houses the research team working on the Advanced Food Technology (AFT) Project, developing food systems for future missions beyond low-Earth orbit.

Prior to October 2010, flight food provisioning was managed by two separate organizations—the bulk of food production and stowage for STS was within the United Space Alliance Flight Crew Equipment (USA FCE) organization, while the SFSL managed both flight food provisioning for ISS and menu development for STS crews. USA FCE had multiple freeze dryers as well as the assembly equipment to manufacture septum adapter assemblies, which are critical components of all rehydratable food items and beverages. The SFSL produced most of the thermostabilized pouched food products through the Space Food Research Facility (SFRF), located on the campus of Texas A&M University. The SFRF was established through a partnership between NASA, Texas A&M University, and Wyle Integrated Sciences and Engineering Group to provide a facility dedicated to the production of foods for space flight and the advancement of food science education and research. Both USA FCE and SFSL contributed important components of the food systems for STS and ISS. With the termination of the Space Shuttle Program, the ISS Program Office had an opportunity to consolidate all food production for human space flight within one facility.

International Space Station Crew of Six

When the ISS food system took shape in the late 1990s, the SFSL was identified as the primary flight food provisioning facility. The ISS food system was developed to provide the

ISS nominal crew of three with half its daily rations (the other half of the daily rations were to be provided by the Russian space program, by international agreement). The ISS food system was based on thermostabilized pouched food products, as opposed to the rehydratable food items that were the mainstay of the STS food system. STS crew member menus were designed to use primarily rehydratable food products, to take advantage of the plentiful supply of water available on the shuttle. As ISS was not designed to generate its own water supply, a food system using thermostabilized pouched foods that do not require the addition of water prior to consumption was planned. Over time, the two food systems blended as STS crew members requested more thermo-stabilized food products and additional rehydratable food items were provided to ISS crew members, thus increasing the variety of foods available to them. This led to an exchange of food items between the USA FCE shuttle food facility and the SFSL ISS facility, thus precluding each organization developing an additional production capability. The SFSL maintained a research focus and relied on USA FCE to produce the bulk of the freeze-dried food items and beverages for ISS. In 2008, the ISS Program Office directed the SFSL to plan for increased food provisioning to support an increase in the ISS crew size of three to six astronauts. This need to accommodate the increased production required both a significant change in SFSL operations and a paradigm shift for the SFSL team from a predominately research orientation to a production orientation.

The first hurdle the team encountered was reimagining the SFSL facility. How do you create a food production facility in an office environment? SFSL team members conducted a process improvement event that was designed to improve the flow of products and materials through the facility. The team evaluated the current work flow, created functional areas to collocate materials and equipment, and reorganized the placement of equipment and materials to best accommodate planned production. Making these changes enabled the team to successfully scale up production. In May 2010, the SFSL ISS Provisioning Team was recognized with a NASA Group Achievement Award for outstanding efforts in the initial provisioning of food to six ISS crew members.

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Food Task Consolidation

By October 2009, the provisioning activities to support crew of six operations were well under way. When the decision was made to consolidate all food provisioning for human space flight within the SFSL, the SFSL Food Task Consolidation group evaluated the challenges. With the decommissioning of the USA FCE food facility, the SFSL would be required to make or procure all freeze-dried food items as well as beverages and ancillary hardware (septum adapter assemblies, straws, utensil kits). The SFSL would also be required to provide all additional STS support required for shuttle flights remaining after October 2010. While this was initially assessed to be one flight (STS-335—a “Launch on Need” rescue mission), as the launch schedule slipped, one flight turned into three after October 2010: STS-133, STS-134, and STS-135 (formerly STS-335).

The Food Task Consolidation group had to plan for the financial and staff resource challenges these opportunities presented, and to reevaluate the available facility space. What worked for provisioning a crew of six with food and hardware support from USA FCE would not work for provisioning all food and hardware required to support crew-of-six operations and the remaining shuttle flights. A facility specifically designed for food production was the ideal; however, a facility with the required floor drains, sealed floors, washable walls, and utility connections did not exist at JSC. It was thus determined to increase the size of the existing facility and modify it as needed to accommodate the NASA-owned equipment being transferred to the SFSL from the USA FCE food facility.

The Food Task Consolidation group in concert with the JSC Integrated Facility Planning Office eventually agreed to an additional 3100 ft² of an adjoining room for staff office space. The relocation of SFSL staff to the adjoining room made further facility modification possible (see figure 1).

One of the ideal conditions identified during the process improvement event was the creation of a “clean packaging environment.” This is not a “clean room,” which is not required for flight food packaging, but a packaging



Fig. 1. Clean packaging “room within a room.”

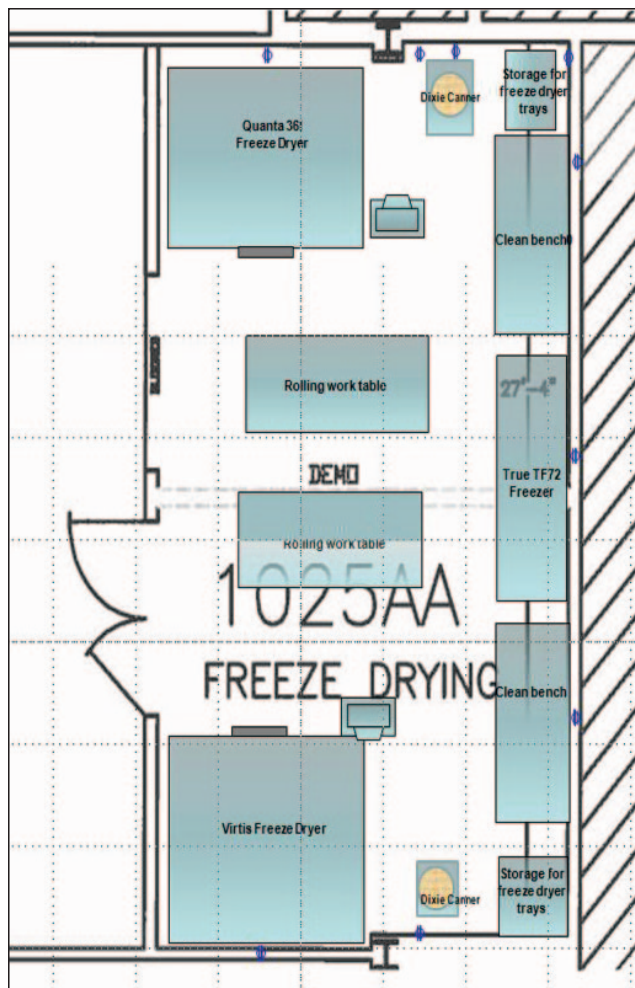


Fig. 2. Equipment placement within freeze drying room.

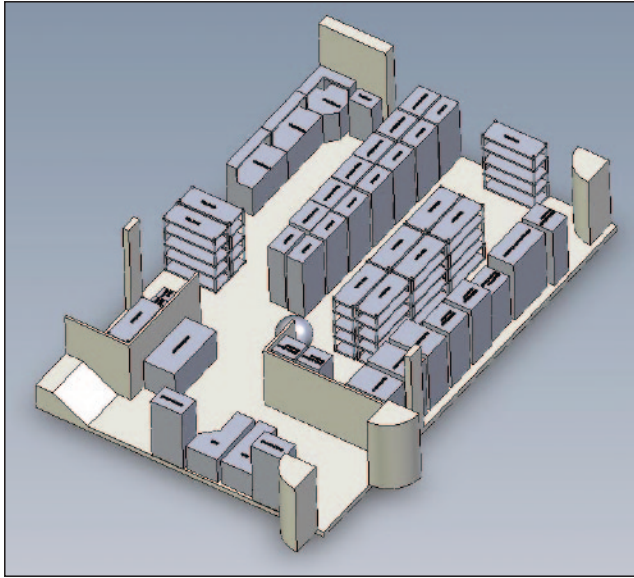


Fig. 3. Three-dimensional layout of work room.

environment with filtered air to ensure that packaged flight food continues to meet NASA microbiological standards for flight food. High-efficiency particulate air [HEPA] filters installed in the ceiling panels provide a positive pressure environment within the clean packaging environment. The additional space and arrangement of equipment supports multiple packaging activities occurring simultaneously in the room (see figure 2).

Prior to the food task consolidation activities, the SFSL maintained packaging equipment and one freeze dryer in two adjacent rooms. A second freeze dryer was required to continue to provide the variety of food items currently available to the crew. A dividing wall was removed and the packaging equipment was relocated to the clean packaging room, thus making space for both freeze dryers as well as for ancillary equipment.

To maintain the flight food inventory and Class I hardware required for ISS flight food provisioning, the SFSL controlled storage space was reconfigured to create separation between finished Class I hardware and Class I ingredients and hardware that was “in work.” This required relocation of three environmental chambers and installation of utilities to support package integrity testing equipment. The current configuration allows flight

hardware to be stowed in containers and prepared for transfer to shipping without leaving the controlled storage area (see figure 3).

The final facility modification involved creation of a “workroom”—i.e., a project work space as well as a materials storage and receiving area. The SFSL team worked together to create a room configuration that best supported all of the required uses of the space: housing for incubators and environmental chambers, and bench-top space for equipment maintenance and troubleshooting as well as for project and materials storage.

The facility modifications are complete and the facility was unveiled at JSC Innovation Day on May 4, 2011. The SFSL is currently working on reformulation of more than 80 flight food items to reduce sodium, in addition to provisioning all U.S. food for ISS and STS and conducting research for future exploration vehicles and missions. As space food systems evolve to meet changing requirements and missions, the SFSL facility is keeping pace.